Adjusting VHR GMPEs to BC (importance of κ_0)

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USGS National Seismic Hazard Map (NSHMp) Workshop on Ground Motion Prediction Equations (GMPEs)

for the 2014 Update

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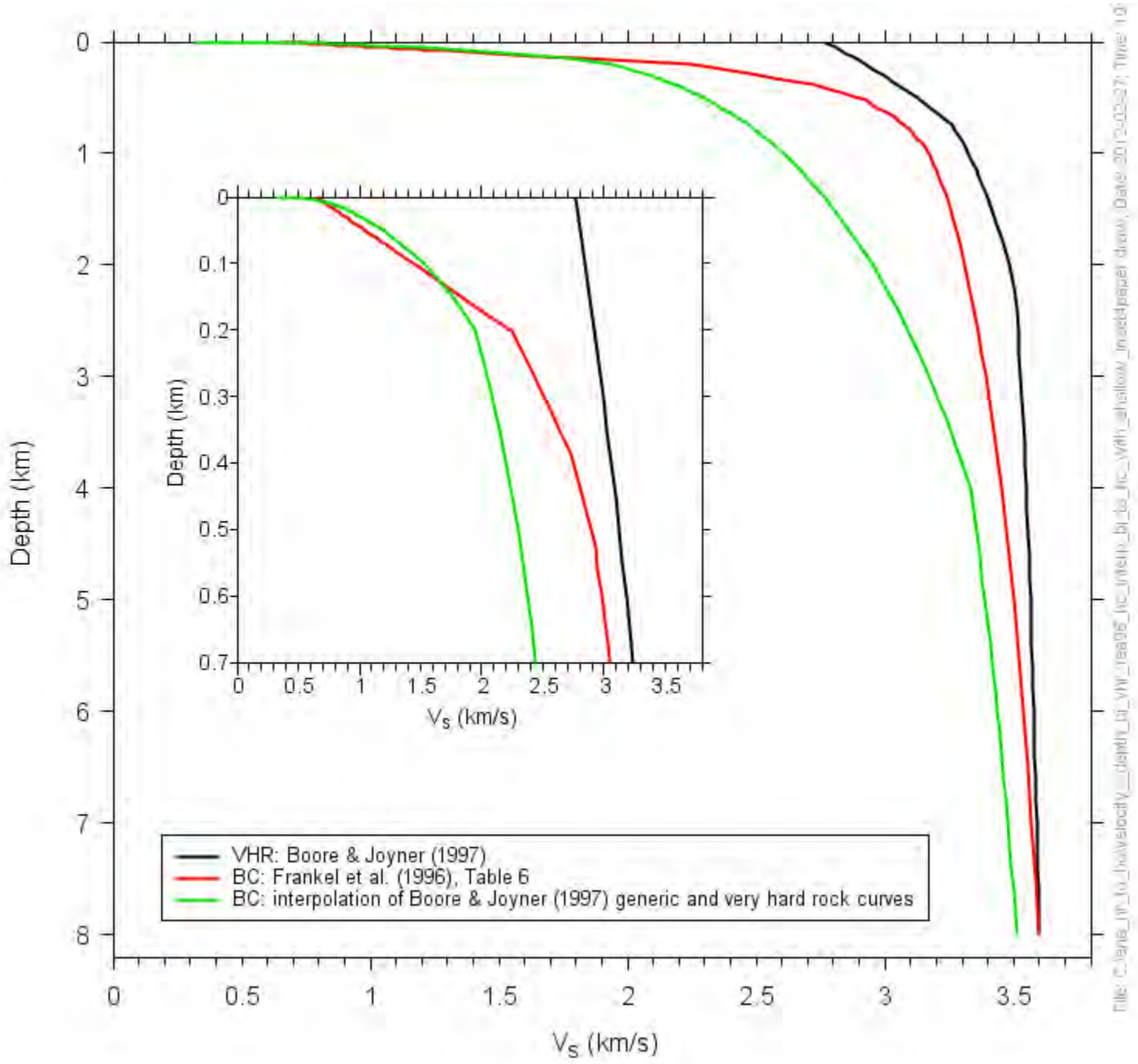
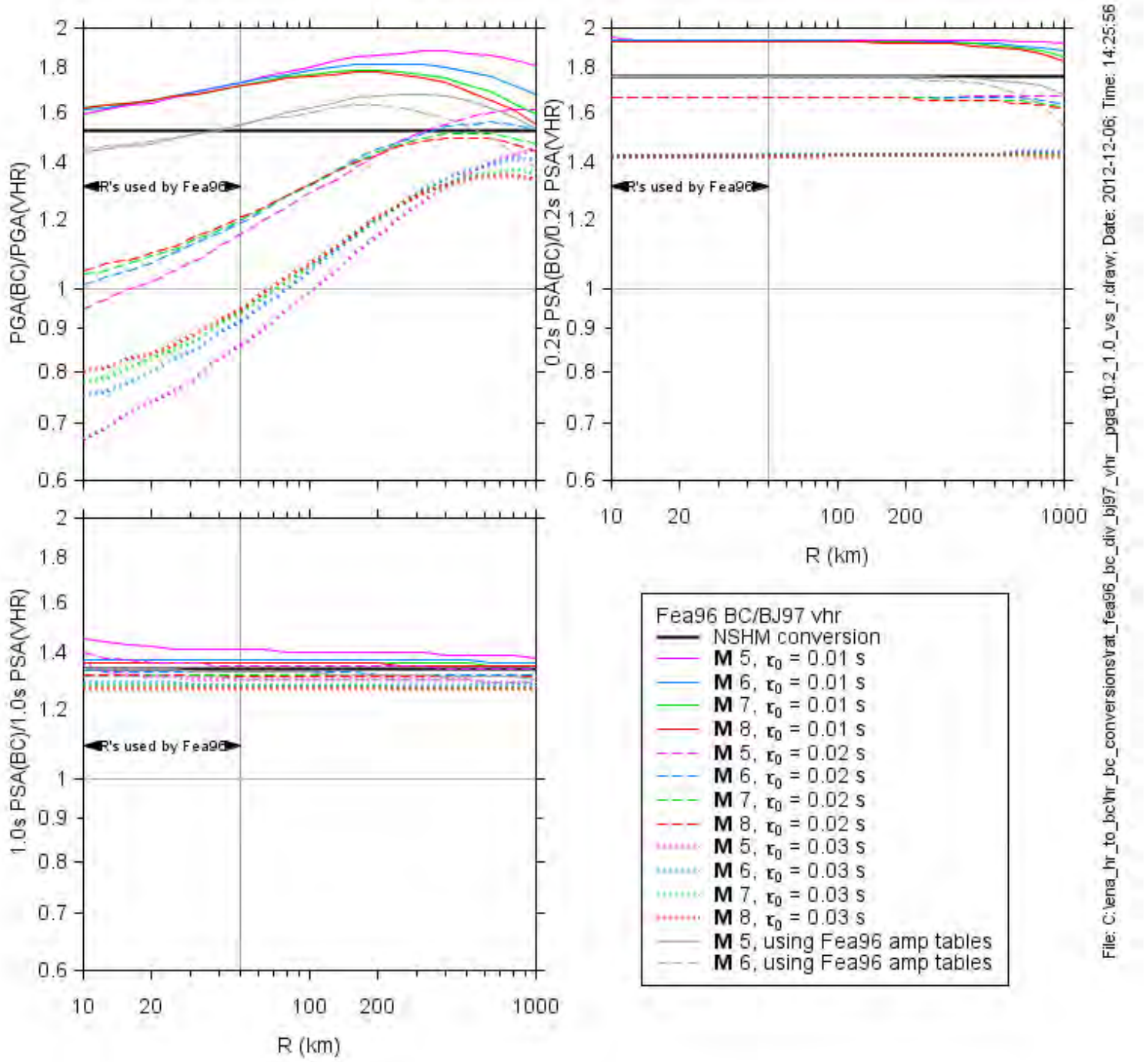
I-House, Berkeley, CA

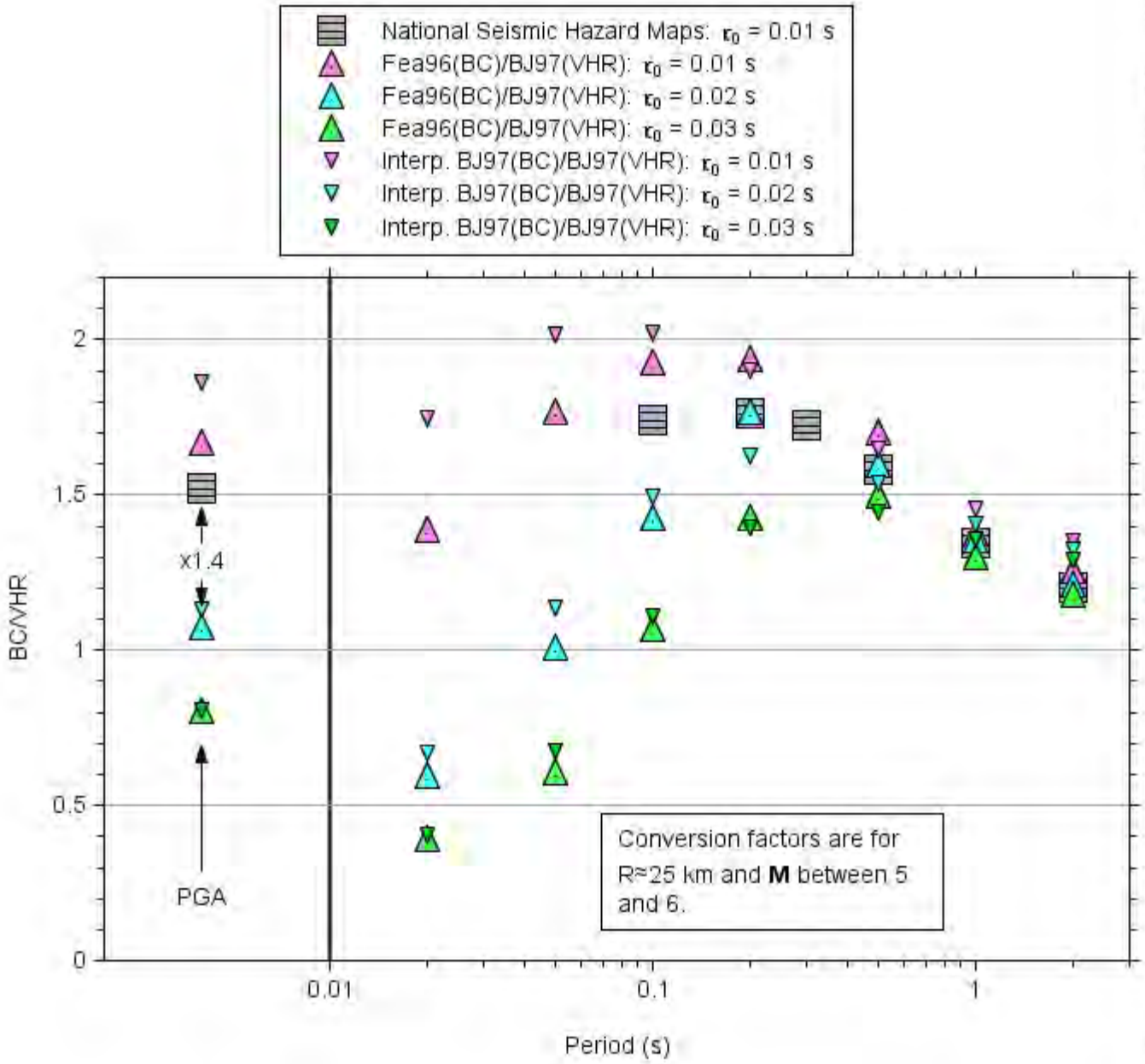
CENA Models used in 2008 USGS NSHMs (Petersen et al., 2008)

Model	Site	κ_0 for BC amps or VHR—BC conversion
Frankel et al.	BC	0.01
Atkinson & Boore	BC	0.02
Toro et al.	VHR	0.01
Somerville et al.	VHR	0.01
Silva et al.	VHR	0.01
Campbell	VHR	0.01
Tavakoli & Pezeshk	VHR	0.01

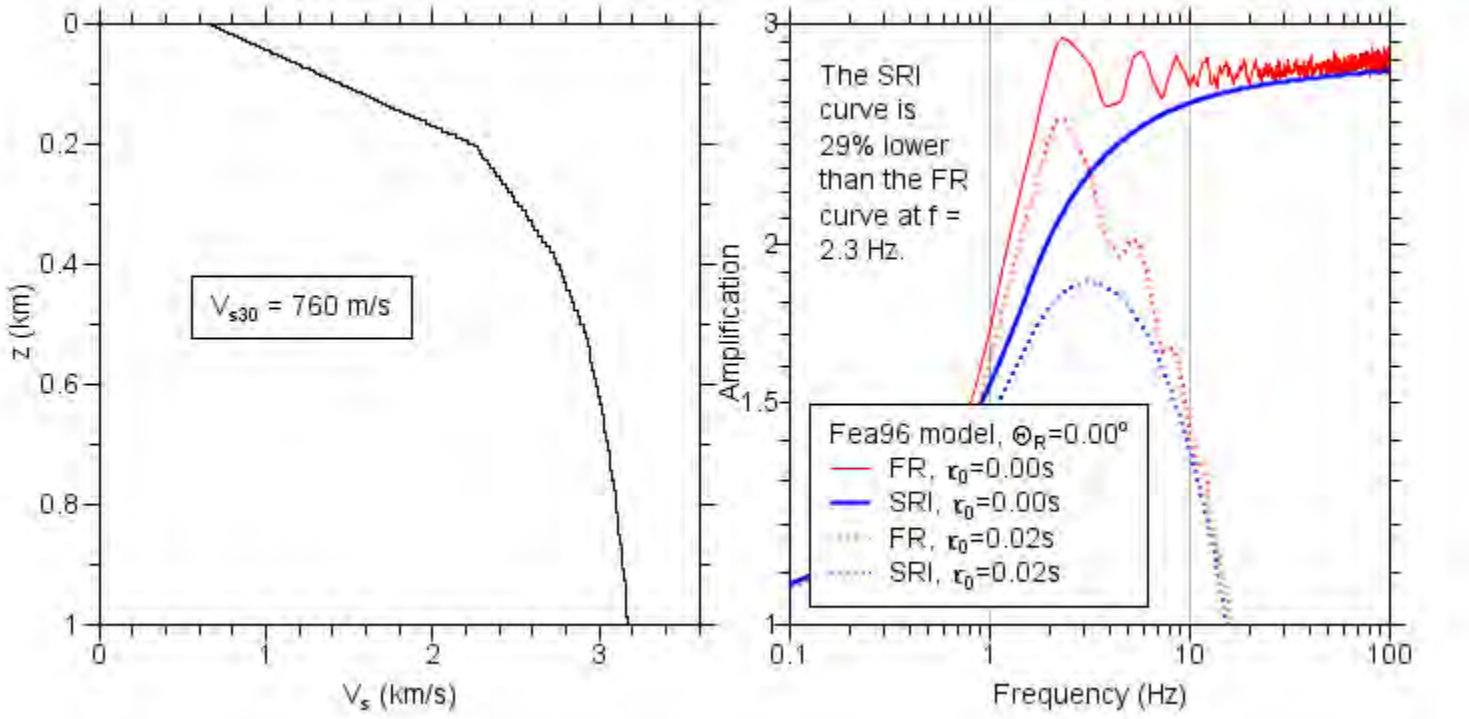
Used same S-wave velocity model


Depth (km)
0
1
2
3
4
5
6
7
8
0
0.5
1
1.5
2
2.5
3
3.5
V_S (km/s)
Depth (km)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
0.5
1
1.5
2
2.5
3
3.5
V_S (km/s)
VHR: Boore & Joyner (1997)
BC: Frankel et al. (1996), Table 6
BC: interpolation of Boore & Joyner (1997) generic and very hard rock curves


PGA(BC)/PGA(VHR)
0.2s PSA(BC)/0.2s PSA(VHR)
1.0s PSA(BC)/1.0s PSA(VHR)
R's used by Fea96
R (km)
Fea96 BC/BJ97 vhr
NSHM conversion
M 5, τ0 = 0.01 s
M 6, τ0 = 0.01 s
M 7, τ0 = 0.01 s
M 8, τ0 = 0.01 s
M 5, τ0 = 0.02 s
M 6, τ0 = 0.02 s
M 7, τ0 = 0.02 s
M 8, τ0 = 0.02 s
M 5, τ0 = 0.03 s
M 6, τ0 = 0.03 s
M 7, τ0 = 0.03 s
M 8, τ0 = 0.03 s
M 5, using Fea96 amp tables
M 6, using Fea96 amp tables
File: C:\ena_hr_to_bc\hr_bc_conversions\rat_fea96_bc_div_bj97_vhr__pga_t0.2_1.0_vs_r.draw; Date: 2012-12-06; Time: 14:25:56

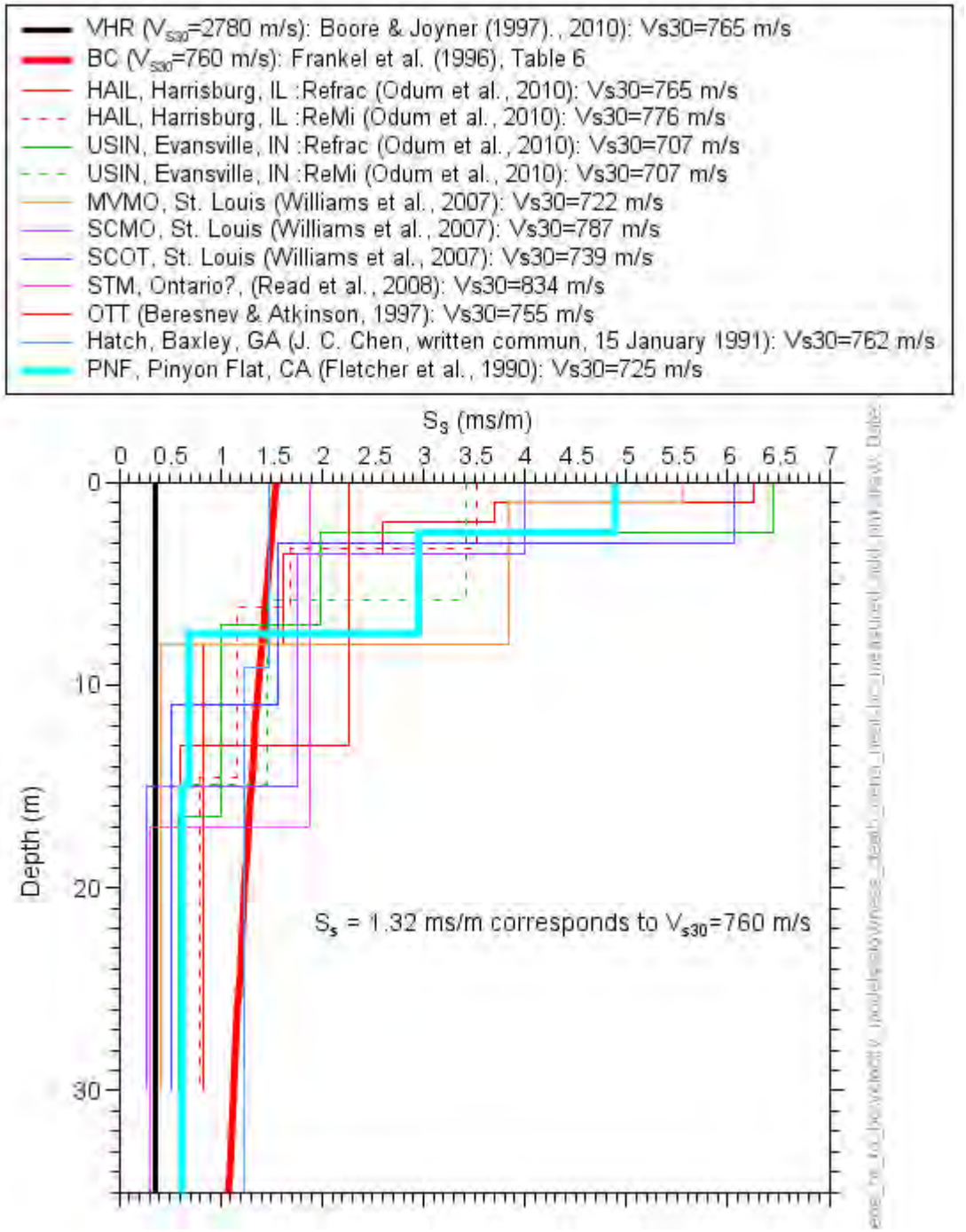

National Seismic Hazard Maps: κ_0 = 0.01 s
Fea96(BC)/BJ97(VHR): κ_0 = 0.01 s
Fea96(BC)/BJ97(VHR): κ_0 = 0.02 s
Fea96(BC)/BJ97(VHR): κ_0 = 0.03 s
Interp. BJ97(BC)/BJ97(VHR): κ_0 = 0.01 s
Interp. BJ97(BC)/BJ97(VHR): κ_0 = 0.02 s
Interp. BJ97(BC)/BJ97(VHR): κ_0 = 0.03 s
BC/VHR
2
1.5
1
0.5
0
x1.4
PGA
0.01
0.1
1
Period (s)
Conversion factors are for R≈25 km and **M** between 5 and 6.

Issue: Method of Site Amp Computation



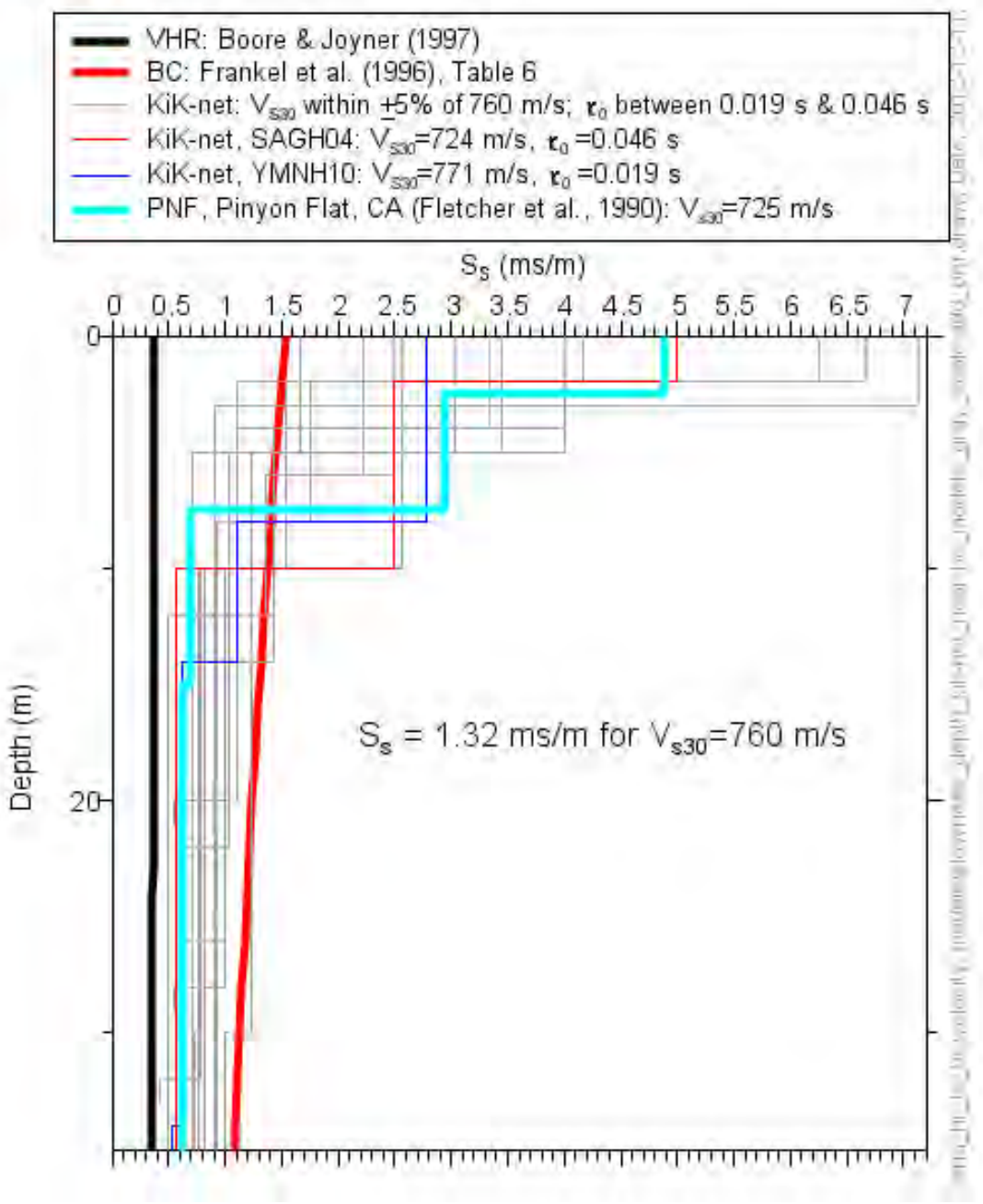
Issue: Vs(z) and κ_0 for CENA Sites

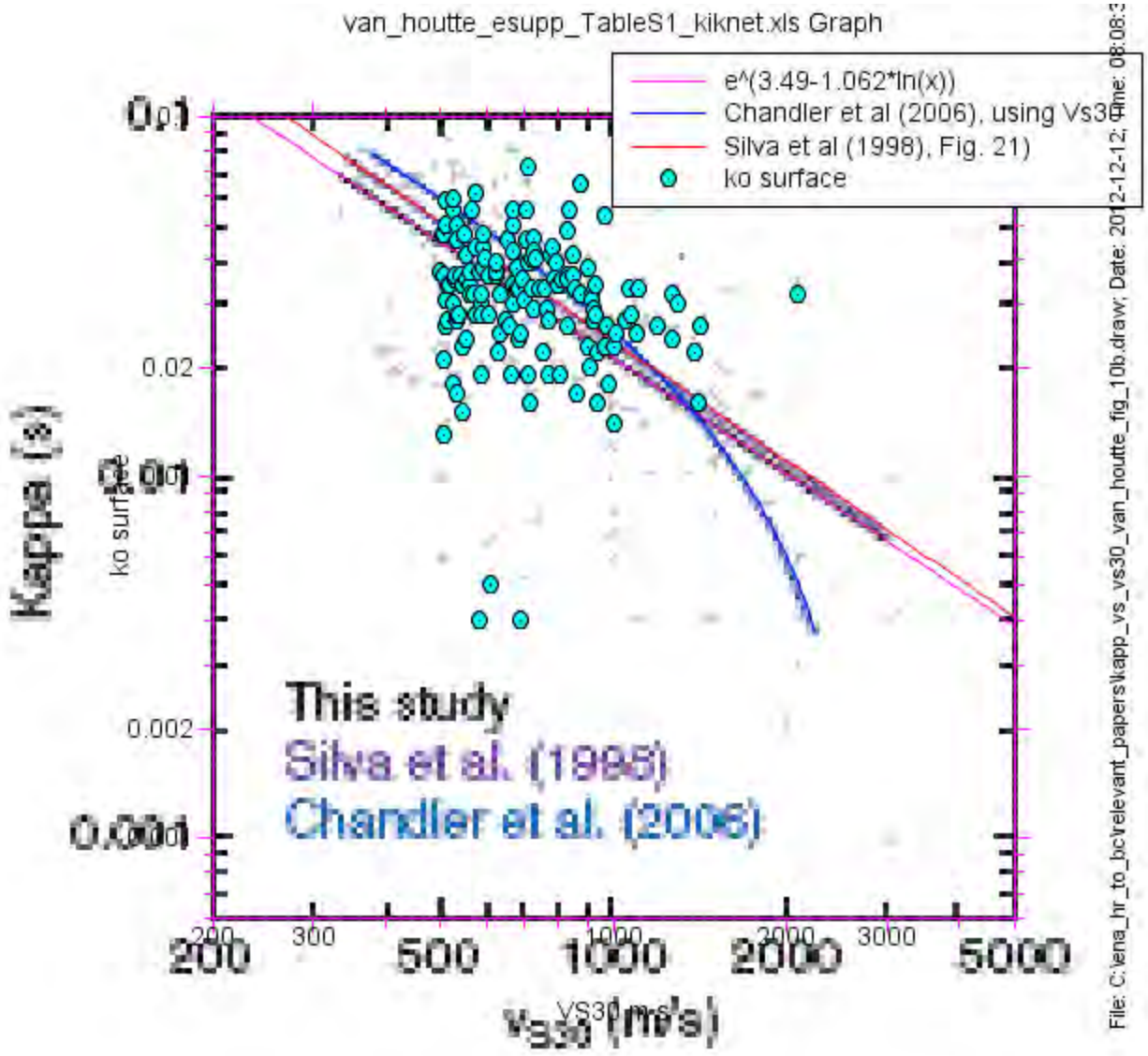
Slowness Profiles for V_{s30}=760 m/s Sites in the central and eastern North America (plus Pinyon Flat, a possible surrogate for a BC site CENA)



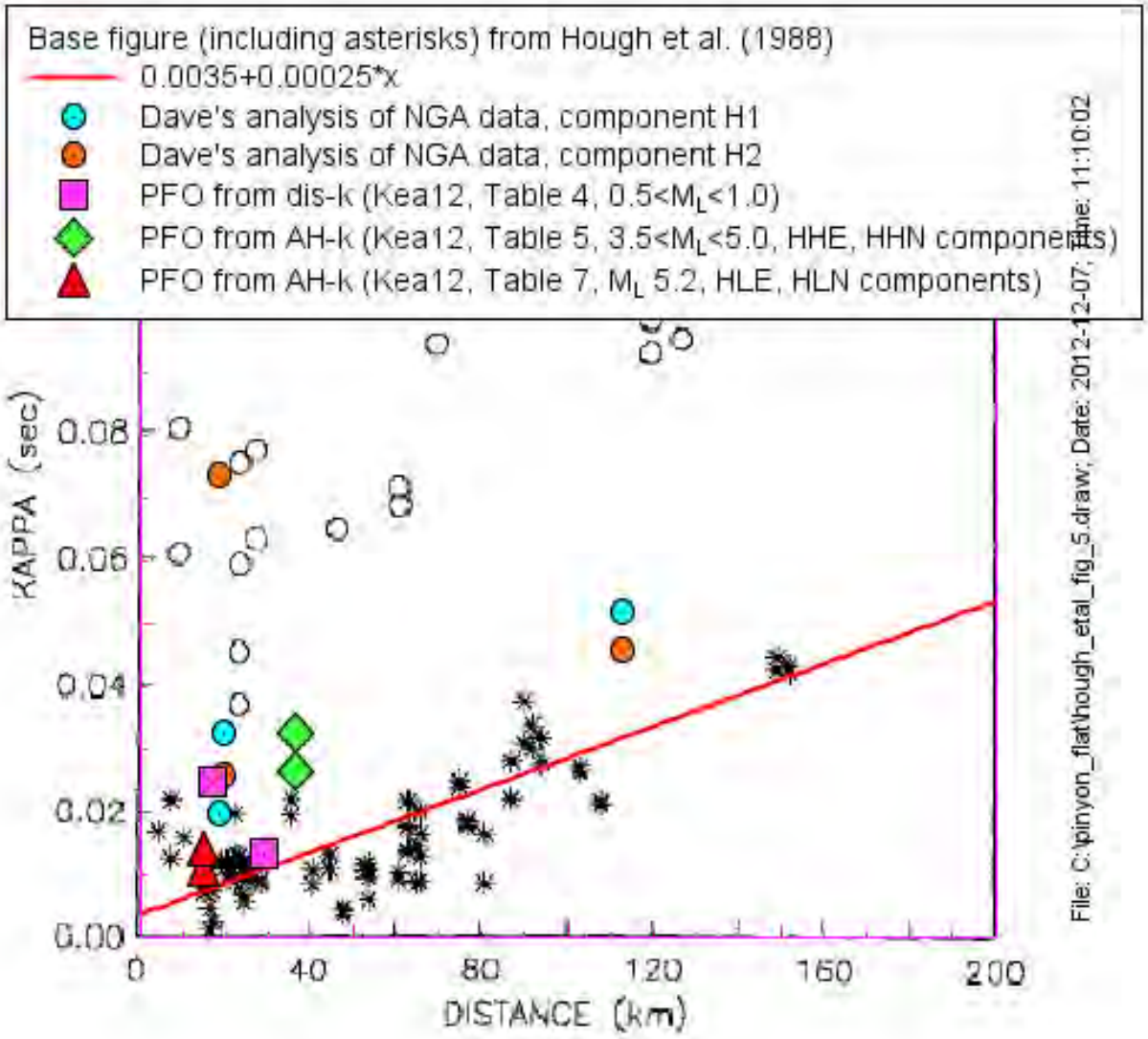
Slowness Profiles for V_{s30}=760 m/s KiK-net Sites (plus Pinyon Flat, a possible surrogate for a BC site CENA)

Note κ_0 for KiK-net

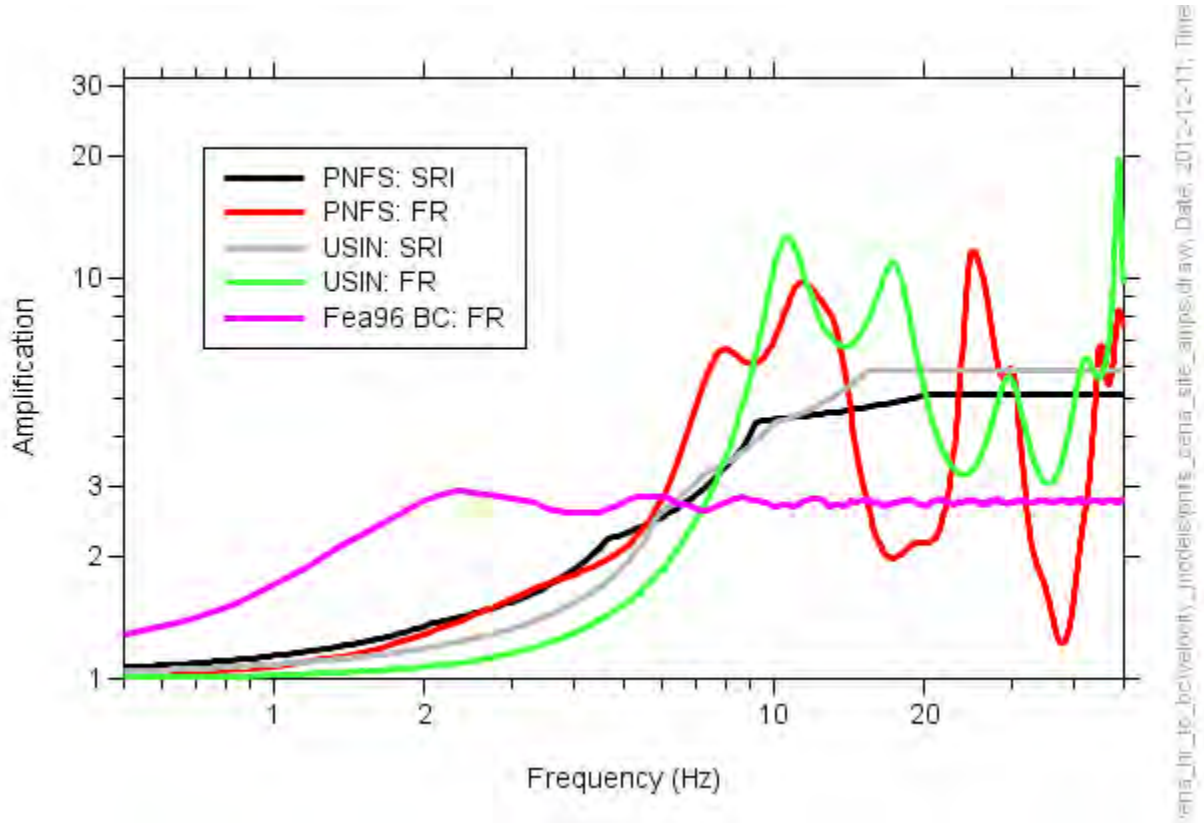



van_houtte_esupp_TableS1_kiknet.xls Graph
e^(3.49-1.062*ln(x))
Chandler et al (2006), using Vs30
Silva et al (1998), Fig. 21)
ko surface
Kappa (s)
ko surface
0.1
0.02
0.002
0.0001
This study
Silva et al. (1998)
Chandler et al. (2006)
200
300
500
1000
2000
3000
5000
VS30 (m/s)
File: C:\ena_hr_to_bc\relevant_papers\kapp_vs_vs30_van_houtte_fig_10b.draw; Date: 2012-12-12; Time: 08:08:3

κ_0 for Pinyon Flat



Issue: Site Amps for CENA sites with V_{s30}~760 m/s compared to Fea96 Vs(z)



Note: Effect of κ_0 not shown, because it is the same for each amp curve

Summary

- VHR—BC adjustment is sensitive to κ_0
- κ_0=0.01 s used by USGS seems to be low
- VHR—BC adjustment can depend on
  - Velocity profile
  - Method of site amplification computation

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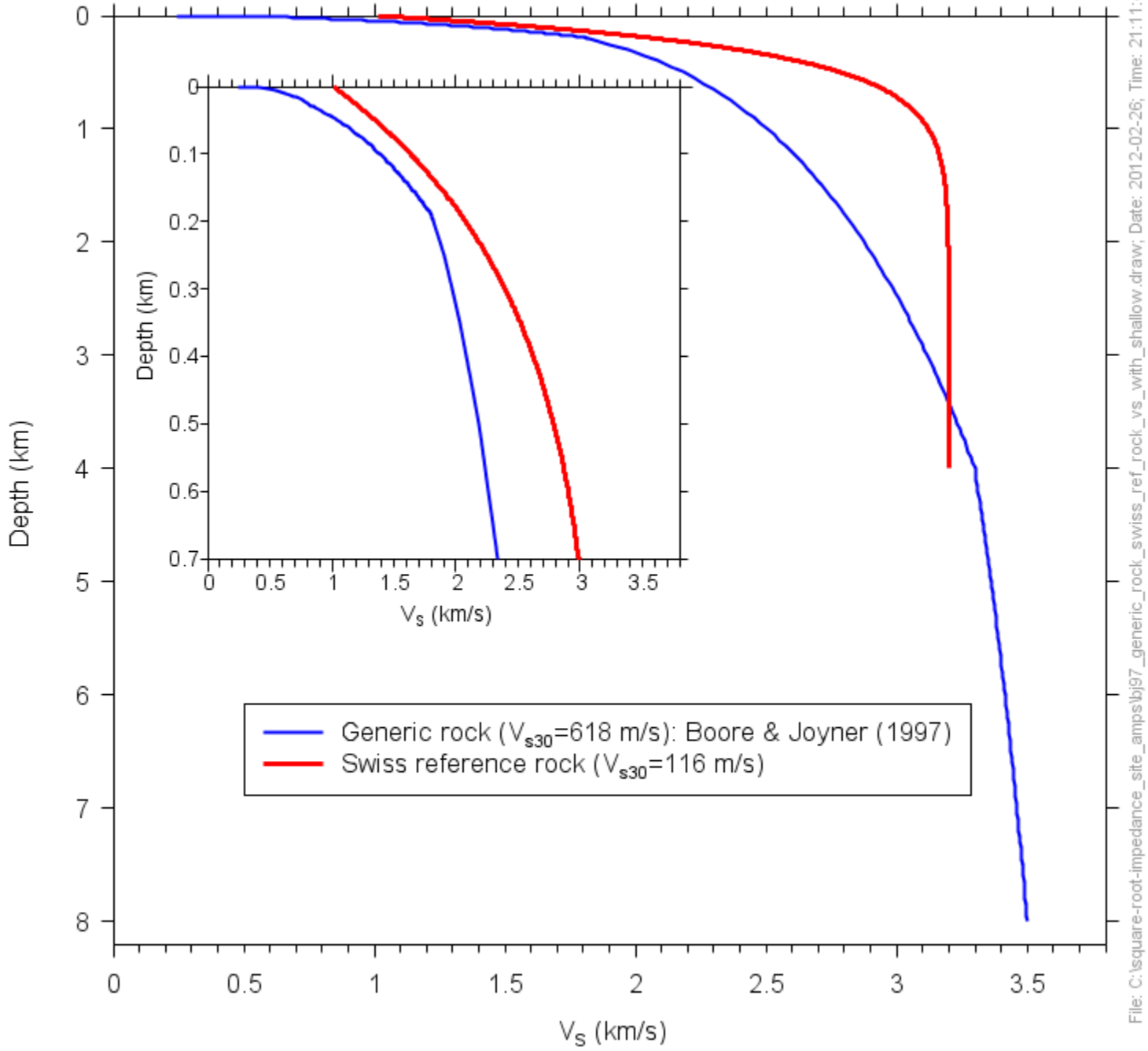
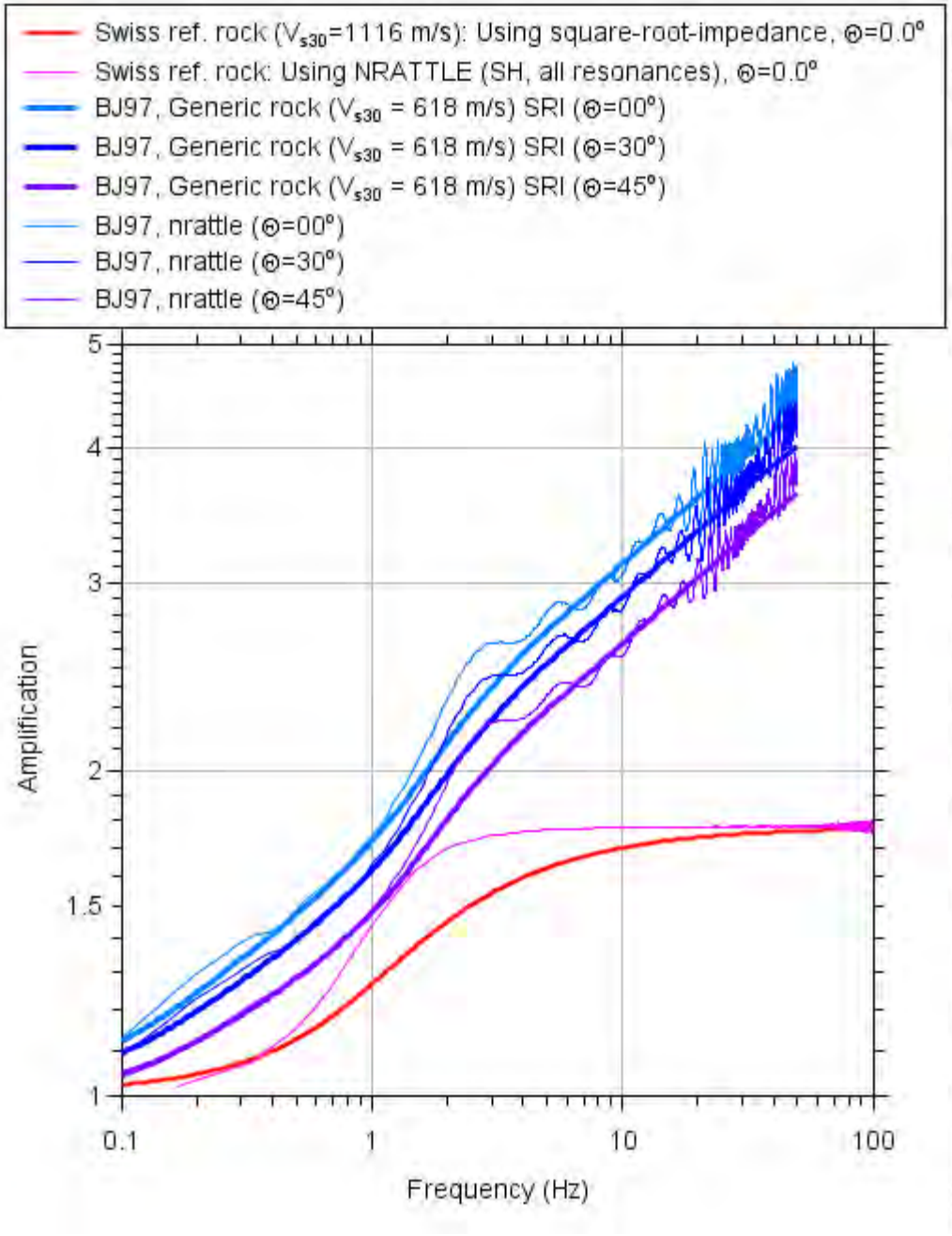
Comparison of square-root impedance and full resonance amplifications


Depth (km)
0
1
2
3
4
5
6
7
8
0
0.5
1
1.5
2
2.5
3
3.5
V_S (km/s)
Depth (km)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
0.5
1
1.5
2
2.5
3
3.5
V_S (km/s)
Generic rock (V_{s30}=618 m/s): Boore & Joyner (1997)
Swiss reference rock (V_{s30}=116 m/s)
File: C:\square-root-impedance_site_ampstbj97_generic_rock_swiss_ref_rock_vs_with_shallow.draw; Date: 2012-02-26; Time: 21:11:41


Swiss ref. rock (V_{s30}=1116 m/s): Using square-root-impedance, ⊛=0.0°
Swiss ref. rock: Using NRATTLE (SH, all resonances), ⊛=0.0°
BJ97, Generic rock (V_{s30} = 618 m/s) SRI (⊛=00°)
BJ97, Generic rock (V_{s30} = 618 m/s) SRI (⊛=30°)
BJ97, Generic rock (V_{s30} = 618 m/s) SRI (⊛=45°)
BJ97, nrattle (⊛=00°)
BJ97, nrattle (⊛=30°)
BJ97, nrattle (⊛=45°)
Amplification
Frequency (Hz)
5
4
3
2
1.5
1
0.1
1
10
100